

QUANTUM INTERFEROMETRY

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ABSTRACT

Recently, several researchers, including yours truly, at the have been able to demonstrate theoretically that quantum photon entanglement has the potential to also revolutionize the entire field of optical interferometry—by providing many orders of magnitude improvement in interferometer sensitivity. The quantum entangled photon interferometer approach is very general and applies to many types of interferometers. In particular, without nonlocal entanglement, a generic classical interferometer has a statistical-sampling shot-noise limited sensitivity that scales like $1/\sqrt{N}$, where N is the number of particles (photons, electrons, atoms, neutrons) passing through the interferometer per unit time. However, if carefully prepared quantum correlations are engineered between the particles, then the interferometer sensitivity improves by a factor of \sqrt{N} (square root of N) to scale like $1/N$, which is the limit imposed by the Heisenberg Uncertainty Principle. For optical (laser) interferometers operating at milliwatts of optical power, this quantum sensitivity boost corresponds to an eight-order-of-magnitude improvement of signal to noise. Applications are to tests of General Relativity such as ground and orbiting optical interferometers for gravity wave detection, Laser Interferometer Gravity Observatory (LIGO) and the European Laser Interferometer Space Antenna (LISA), respectively.